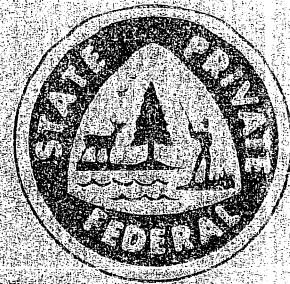


DIVISION OF FOREST PEST CONTROL



Northeastern Area State & Private Forestry

A-70-7

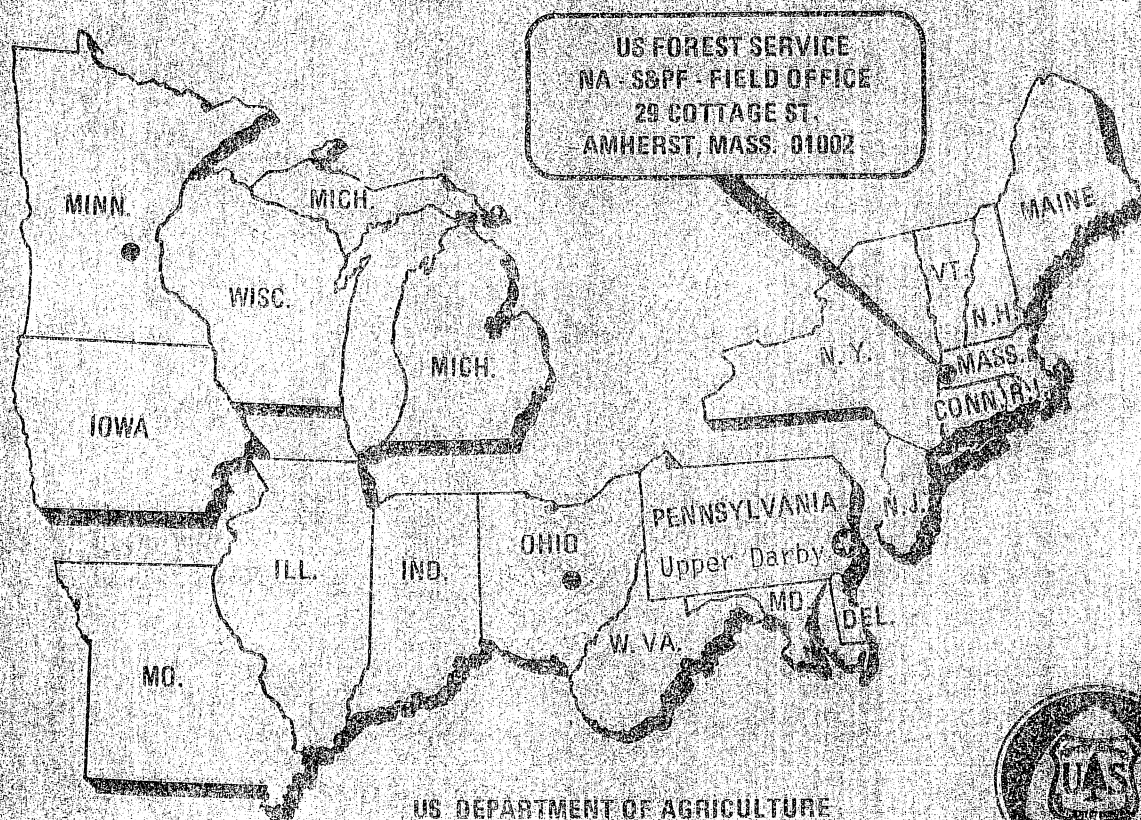
5220

ROOT DISEASE SURVEY
Blake Hill Red Pine Plantation
Groton State Forest - Vermont

by
James S. Hadfield and H. Brenton Teillon

May 1970

Cooperative Report
Amherst Field Office - Vermont Department of Forests & Parks



US DEPARTMENT OF AGRICULTURE
FOREST SERVICE



INTRODUCTION

Foresters managing the Blake Hill red pine plantation have been aware of a pathological problem in the plantation for the past 10-12 years. Intermittently, from 1958 to the present, numerous dead, dying or wind-thrown trees in small groups have been found throughout the plantation. The roots on many of the wind-thrown trees had broken off near the root collar, a sign of root rot.

While the small yearly losses have not been particularly alarming in light of the dense stocking of the stand as a whole, the continuing mortality progressing outward from a number of scattered infection centers has created some rather large openings which are beginning to cut into the crop tree potential of the plantation. Until the discovery of Fomes annosus in 1969, Armillaria mellea had been the only root rotting fungus known to be present in the plantation. However, isolations of infected roots have never been made and the apparent aggressiveness of the pathogen in this instance was unusual for A. mellea unless the trees had been predisposed to attack by some kind of physiological stress. Lacking conclusive evidence of the primary cause of tree mortality in this plantation, the problem appeared to warrant further investigation so a root disease survey was conducted in December of 1969 - Survey results and recommendations for further study are presented in this report.

STAND AND LOCATION HISTORY

The Blake Hill red pine plantation is located in the southwest corner of Peacham Township, Caledonia County, Vermont. Prior to reforestation, the plantation site was used primarily as pasture and meadow, with some land under cultivation. The plantation was established in 1920 by CCC labor; the 3-0 stock being hand planted by 6 foot by 6 foot spacing, over 50 acres.

Cultural practices were first undertaken in 1934-36 when the stand was thinned and pruned. Three major thinnings followed in 1955, 1960 and 1965 for a total harvest of 266 cords of wood. Small volumes of cord wood were harvested from snow damaged trees in 1953, 1955 and intermittently from 1958 to 1969 from dead, dying and wind-thrown trees. No records were kept of the stand density or basal area before or after any of these operations. The total harvest from this stand to date exceeds 360 cords.

The first indication that a root disease problem existed appeared in 1957-58 when noteworthy mortality of single trees and small groups of trees began to occur throughout the plantation. Compartment records for the interim 1958 to 1969 list intermittent small salvage sales required to clean up dead, dying and wind-thrown trees. These wind-thrown trees revealed root systems broken off at or near the root collar; in some cases, the remaining portion of the roots were partially rotted. A. mellea was frequently found on the dying, dead and wind-thrown trees. The fungus was identified from mycelial fans and rhizomorphs. Later, forest pathologists visiting the stand were surprised at the seemingly aggressive nature of A. mellea and suspected that other organisms or factors might be involved, but no intensive investigations were made.

STAND DESCRIPTION

The plantation is located at the base of the southeast side of Blake Hill, Grotor State Forest. Aspect is east by southeast. Mean elevation is about 1700 feet ranging from approximately 1750 to 1670 feet. Topography for most of the plantation is a relatively flat slope with the easterly edge inclined upward onto the foot of Blake Hill. The soil for the relatively flat sloped area is typed 1011 Bc (SCS) which is a stony Berkshire loam, well drained soil on a 3-15% slope. The westerly edge is also typed Berkshire loam (1011D) on a 15 to 25% slope.

Site index (based on height at age 50 years) is approximately 70. Tree height averages 69 feet, having good form, small limbs and good natural pruning. Crowns are relatively small and uniform; crown length usually not exceeding 20-25% of the tree height. Approximately 15 acres in the plantation have been underplanted with white, red and norway spruce and white pine.

METHODS

Plot Layout and Stand Measurements

Single tree plots were systematically laid out at two chain intervals along transects spaced 2.5 chains apart throughout the plantation. Transects were run in approximately a north-south direction (344°) using hand compass and pacing. The tree closest to the plot point was selected as the sample tree. Seventy-one (71) sample trees were selected, numbered, banded and mapped for easy relocation.

The total tree height, merchantable height and diameter at breast height of each sample tree was measured using a diameter tape and Haga altimeter. Basal area surrounding each sample

tree was measured by use of 10 factor prism. Number of growth rings per last inch of diameter growth was measured from increment borings taken at breast height from every 5th tree.

Root Isolations

Duff and soil were scrapped away from a root a minimum of one inch in diameter on both the north and south side of each sample tree. The presence or absence of pitch on the surface of each root was recorded. Ninety-five percent alcohol was poured onto a small portion of each root, an increment borer dipped in alcohol was then used to extract a $3/4 - 1\ 1/2$ inch core from each root. If pitch was present on the root, the core was taken from the pitchy area. The cores were then placed in vials containing 10 percent chlorox and shaken for 10-20 seconds. After this, the cores were transferred to numbered vials containing sterile water and taken to the Amherst Field Office.

At Amherst, the cores were removed from the vials, dipped into 70 percent alcohol and flamed. Both cores from each tree were placed in petri dishes containing 2 percent malt extract agar. The petri dishes were examined at regular intervals for the presence of organisms, which were identified as soon as possible. In many cases, it was necessary to transfer organisms to new dishes to prevent them from being overrun by faster growing fungi and bacteria.

RESULTS

Stand Measurements

Stand measurements are presented in Table No. 1.

The deviations about the mean for measurements of d.b.h., total tree height and number of rings per inch is not great, but is quite large for Basal Area measurements. The mean basal area for the plantation was lowered by measurements from plots located at the edge of openings created by group kills and along roadways..

RESULTS

Root Isolations

Isolation results, by individual roots, are listed in Table 1. Verticicladiella procera, Kendrick was the most commonly isolated organism followed in frequency by several species of bacteria, and sterile black-green fungus. (Table 2).

The relationship of pitchy roots and isolation of V. procera was statistically tested by means of a Chi-square. The relationship is highly significant at the 0.5 percent level. The relationships of basal area, total height, and number of rings per last inch of growth to pitchy roots and isolations of V. procera were also tested. There were no significant relationships.

V. procera grew from the xylem and cambium, other organisms seemed to grow primarily from the small disc of bark remaining on the cores.

DISCUSSION

We had expected to find a large portion of the Blake Hill plantation infected with A. mellea because of the widespread occurrence of this fungus on dead trees. Ever since 1958, people have felt A. mellea was possibly responsible for the mortality in the plantation.

F. annosus, first found on 2-3 stumps during the summer of 1969, was not isolated from any of the sampled roots.

The bacterial, black-green sterile fungus, etc. are in all likelihood saprophytes in the bark and are not responsible for cambial necrosis. The highly significant statistical relationship between pitchy roots and isolation of V. procera makes this especially likely.

A review of the literature has revealed some points which should be investigated in the Blake Hill plantation. V. procera has been associated with lesions on red and white pine roots growing on imperfectly drained soil. (1,3) Trees infected by members of the genus Verticicladiella commonly exhibit reduced height growth for four to five years before they die. (2)

Small areas of the Blake Hill plantation are poorly drained. The disease is in such locations but can also be found on well drained soils in the stand. The disease does not seem to be related to drainage.

It is also possible the plantation was under stress from overstocking, thus allowing V. procera to invade weakened trees. This will be investigated this summer.

An extensive report will be issued in the fall of 1970 after further studies have been completed.

RECOMMENDATIONS

1. Examine the soil at various points in the plantation for determination of drainage classes.
2. Examine the root systems of 5-10 trees in detail to determine the site of pathogen penetration, extent of cambial necrosis, and strain.
3. Determine the current site index at various points in the plantation.
4. Examine current year's needles to determine if reduction in length is an indication of infection by V. procera.
5. Conduct greenhouse inoculations to determine effects of soil moisture, soil temperature, wounding upon infection of red and white pine by V. procera.
6. Determine the role of insects in the deterioration of the plantation.

REFERENCES

1. DeMent, J. A. and E. L. Stone 1968 Influence of Soil and Site on Red Pine Plantations in New York. II Soil Type and Physical Properties. Cornell University Agricultural Experiment Station Bulletin 1020
2. Wagener, W. W. and J. L. Mielke 1961. A Staining-Fungus Root Disease of Ponderosa, Jeffrey, and Pinyon Pines. Plant Disease Reporter 45(11):831-835
3. West Virginia Department of Agriculture 1969 Annual Summary. Forest Insect and Disease Newsletter.

TABLE 1.

ROOT DISEASE SURVEY - WINTER, 1969
BLAKE HILL RED PINE PLANTATION
GROTON STATE FOREST

Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
1	10.5	100	62	17	+	+	Pullularia	Bacteria
2	12.4	90	76		+	+	Bacteria	Verticicladiella
3	12.9	90	62		+	+	Pullularia	Verticicladiella
4	13.3	100	74		+	+	Verticicladiella	Verticicladiella
5	10.3	100	67		+	-	Verticicladiella	Nothing
6	13.3	100	70	14	+	+	Verticicladiella	Verticicladiella

Table 1 (cont.)

Table No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	<u>Pitchy Roots</u>		Culture Results	
					North	South	North	South
7	11.3	140	63		+	+	Verticicladiella	Verticicladiella
8	11.2	160	82		-	-	Verticicladiella	Verticicladiella
9	15.9	80	69		-	+	Bacteria Sterile hyaline mycelium	Nothing
10	9.0	110	63		+	+	Verticicladiella	Verticicladiella Bacteria Sterile hyaline mycelium
11	12.5	90	72	12	-	-	Verticicladiella	Verticicladiella
12	10.3	110	69		+	+	Black green sterile mycelium	Verticicladiella
13	7.5	140	67		-	-	Bacteria	Penicillium
14	10.9	120	73		-	+	Trichoderma	Sterile hyaline mycelium
15	11.0	130	67		-	-	Actinomucor	Nothing

Table 1 (cont.)

Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
16	11.0	150	74	12	-	-	Sterile hyaline mycelium	Trichoderma
17	11.8	170	71		+	+	Verticicladiella	Verticicladiella
18	8.0	160	64		+	+	Verticicladiella	Pullularia
19	10.7	110	68		+	+	Verticicladiella	Bacteria
20	12.3	80	67		-	-	Black green sterile mycelium	Verticicladiella
21	11.0	60	79	15	-	+	Trichoderma	Verticicladiella
22	10.6	80	82		+	+	Verticicladiella	Verticicladiella
23	12.5	100	76		+	+	Verticicladiella	Verticicladiella
24	10.0	130			-	-	Black green sterile mycelium	Verticicladiella Black green sterile mycelium

Table 1 (cont.)

Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
25	10.6	140	75		-	-	Verticicladiella	Verticicladiella
26	11.6	150	71	12	-	+	Sterile hyaline mycelium	Verticicladiella
27	9.7	100	68		+	-	Penicillium	Verticicladiella Mortierellaceae
28	10.8	170	67		+	-	Verticicladiella	Penicillium
29	8.8	190	63		-	-	Nothing	Trichoderma Actinomucor
30	8.0	130	54		-	-	Actinomucor	Actinomucor
31	11.3	130	69	17	-	-	Sterile hyaline mycelium	Actinomucor Trichoderma
32	15.6	120	69		-	-	Actinomucor	Actinomucor
33	11.5	150	76		+	+	Black green sterile mycelium	Bacteria Sterile hyaline mycelium
34	13.2	160	70		-	-	Bacteria Black green sterile mycelium	Actinomucor

Table 1 (cont.)

Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
35	14.0	150	80		+	-	Verticicladiella	Bacteria
36	Hardwood - No plot tree							
37	8.6	160	58		-	-	Bacteria	Actinomucor
38	10.3	220	65		+	-	Sterile hyaline mycelium	Bacteria
39	9.9	180	65		-	-	Pullularia Actinomucor	Bacteria Black green sterile mycelium
40	9.2	180	74	9	-	-	Black green sterile mycelium	Penicillium
41	10.9	110	71		-	-	Bacteria	Sterile hyaline mycelium
42	10.6	200	65		-	-	Bacteria	Black green sterile mycelium
43	11.3	160	68		-	-	Bacteria	Bacteria
44	13.4	90	75		-	-	Bacteria	Sterile hyaline mycelium

Table 1 (cont.)

Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
45	9.6	140	64	13	-	+	Actinomucor	Verticicladiella Trichoderma
46	10.7	130	66		-	+	Verticicladiella Mortierellaceae	Verticicladiella
47	12.7	130	75		+	-	Black green sterile mycelium	Black green sterile mycelium
48	11.4	110	78		-	-	Bacteria	Sterile hyaline mycelium
49	12.4	90	80	17	-	-	Nothing	Black green sterile mycelium
50	9.7	140	73	14	-	-	Black green sterile mycelium	Penicillium Pullularia
51	11.5	150	80		-	-	Sterile hyaline mycelium	Sterile hyaline mycelium
52	10.9	130	80		-	-	Bacteria	Bacteria
53	13.2	110	75		-	-	Black green sterile mycelium	Bacteria
54	12.8	140	81		-	-	Actinomucor	Sterile hyaline mycelium

Table 1 (cont.)

Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
55	12.0	110	66	11	-	-	Actinomucor	Mortierellaceae
56	12.5	120	66		-	-	Nothing	Actinomucor
57	11.7	140	67		-	-	Black green sterile mycelium	Nothing
58	9.4	150	63		-	-	Bacteria	Cephalosporium
59	11.3	140	70		-	-	Mortierellaceae	Penicillium
60	9.3	160	67	15	-	-	Bacteria	Black green sterile mycelium Mortierellaceae Actinomucor
61	12.4	120	77		-	-	Bacteria Black green sterile mycelium	Penicillium
62	10.0	130	72		-	-	Bacteria Black green sterile mycelium	Black green sterile mycelium Mortierellaceae
63	9.5	130	74		-	+	Trichoderma	Verticicladiella Sterile hyaline mycelium

Table 1 (cont.)

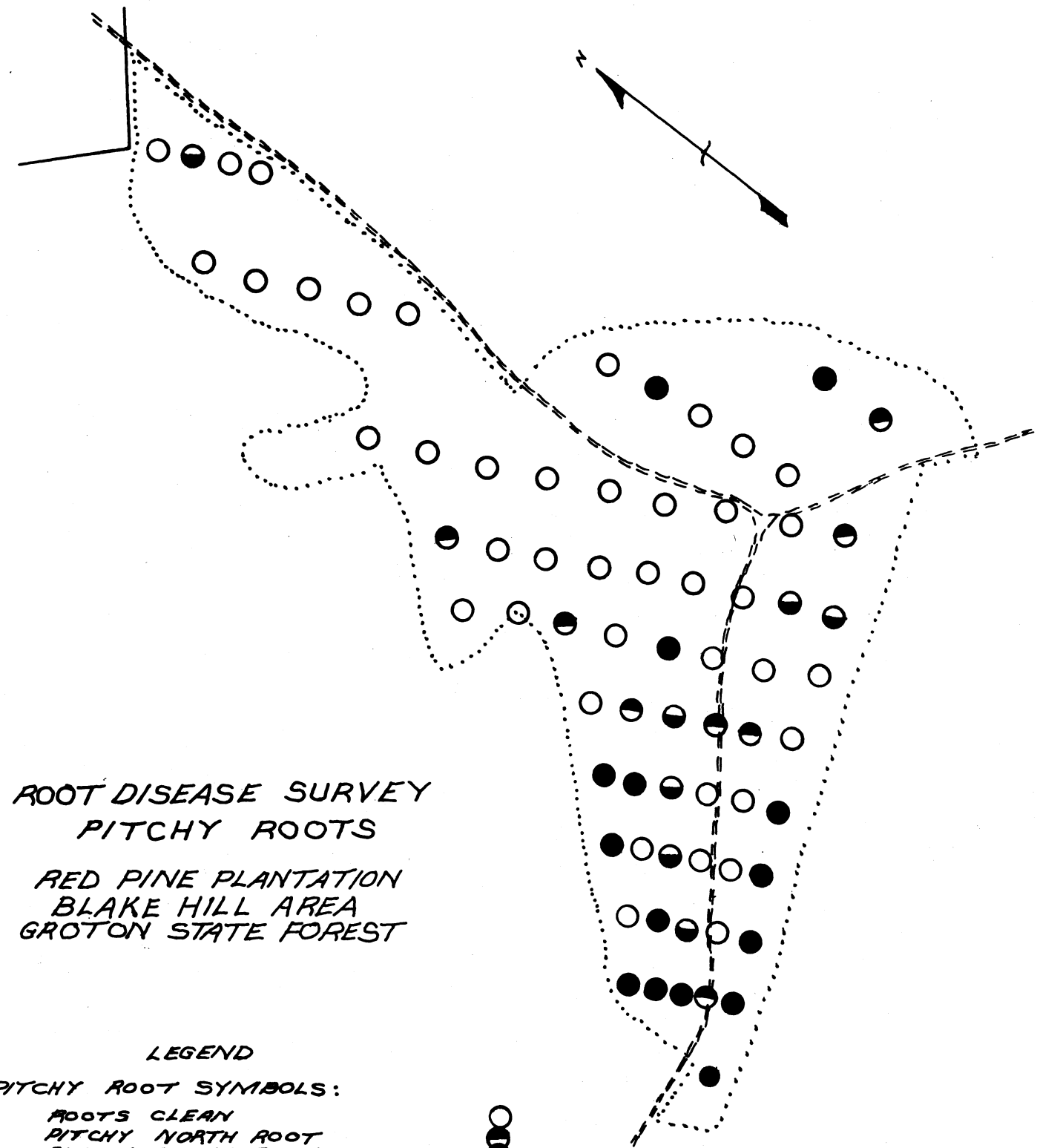
Tree No.	DBH	Basal Area	Total Height	No. Rings/ Last Inch	Pitchy Roots		Culture Results	
					North	South	North	South
64	8.8	120	70		-	-	Mortierellaceae	Black green sterile mycelium
65	10.8	100	67	8	-	-	Black green sterile mycelium	Actinomucor
66	12.1	100	73		+	+	Trichoderma	Penicillium
67	11.7	120	68		-	-	Bacteria Penicillium	Black green sterile mycelium
68	10.8	110	73		-	-	Mortierellaceae	Mortierellaceae
69	11.5	100	72		-	-	Black green sterile mycelium	Black green sterile mycelium
70	10.8	90	70	13	+	-	Verticicladiella	Penicillium
71	10.8	110	67		+	+	Verticicladiella	Verticicladiella
Average	11.0	122	69.3	13.3				

Table 2.

Organisms Isolated from Red Pine Roots
Blake Hill Plantation
Groton State Forest

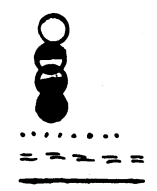
<u>ORGANISM ISOLATED</u>	<u>FREQUENCY OF ISOLATION</u>
<u>Verticicladiella procera</u>	38
Bacteria	26
Black-green sterile mycelium	24
<u>Actinomuror</u> *	17
Hyaline sterile mycelium	13
<u>Penicillium</u>	10
<u>Mortierellaceae</u>	9
<u>Trichoderma viride</u>	8
<u>Pullularia pullulans</u>	5
<u>Cephalosporium</u>	1
Nothing	7

* Identified by Dr. Margaret Bigelow, Botany Department,
University of Massachusetts

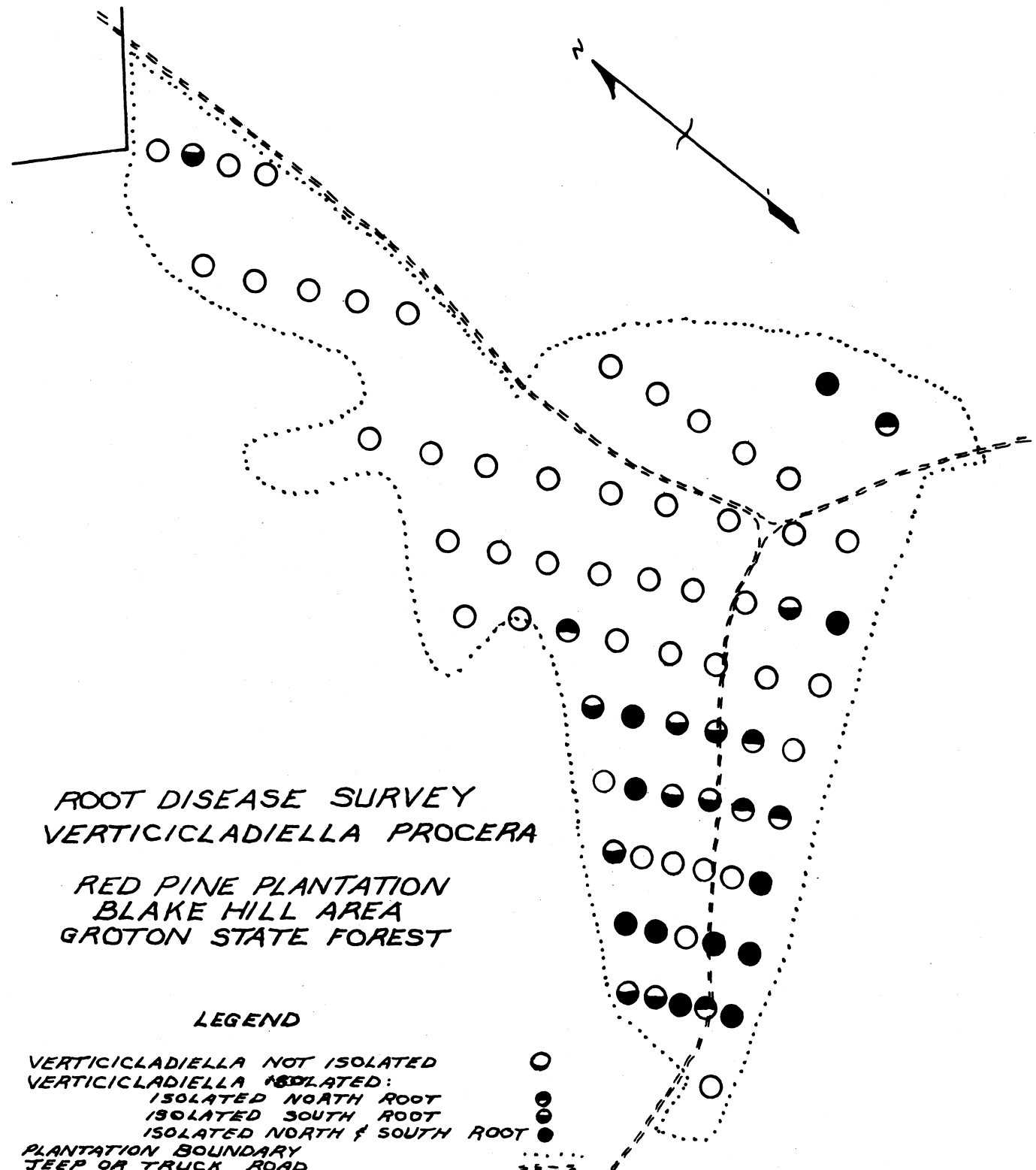


ROOT DISEASE SURVEY
PITCHY ROOTS
RED PINE PLANTATION
BLAKE HILL AREA
GROTON STATE FOREST

LEGEND
PITCHY ROOT SYMBOLS:
ROOTS CLEAN
PITCHY NORTH ROOT
PITCHY SOUTH ROOT
PITCHY NORTH & SOUTH ROOT
PLANTATION BOUNDARY
JEEP OR TRUCK ROAD
STATE FOREST BOUNDARY

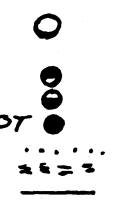


SCALE : 1" = 5 CHNS.

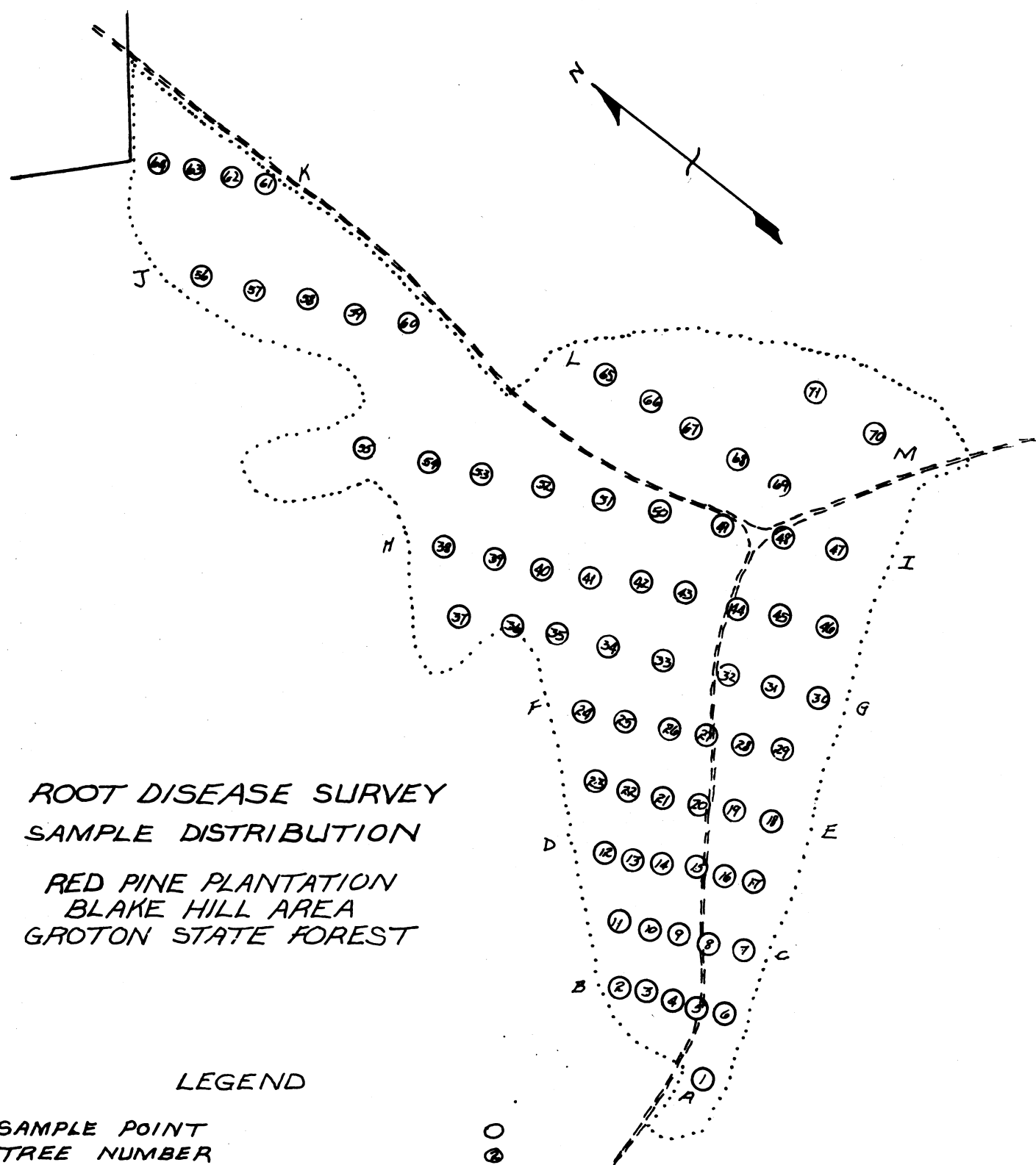


ROOT DISEASE SURVEY
VERTICICLADIELLA PROCERA
RED PINE PLANTATION
BLAKE HILL AREA
GROTON STATE FOREST

LEGEND
VERTICICLADIELLA NOT ISOLATED
VERTICICLADIELLA ISOLATED:
ISOLATED NORTH ROOT
ISOLATED SOUTH ROOT
ISOLATED NORTH & SOUTH ROOT
PLANTATION BOUNDARY
JEEP OR TRUCK ROAD
STATE FOREST BOUNDARY



SCALE : 1" = 5 CHNS.



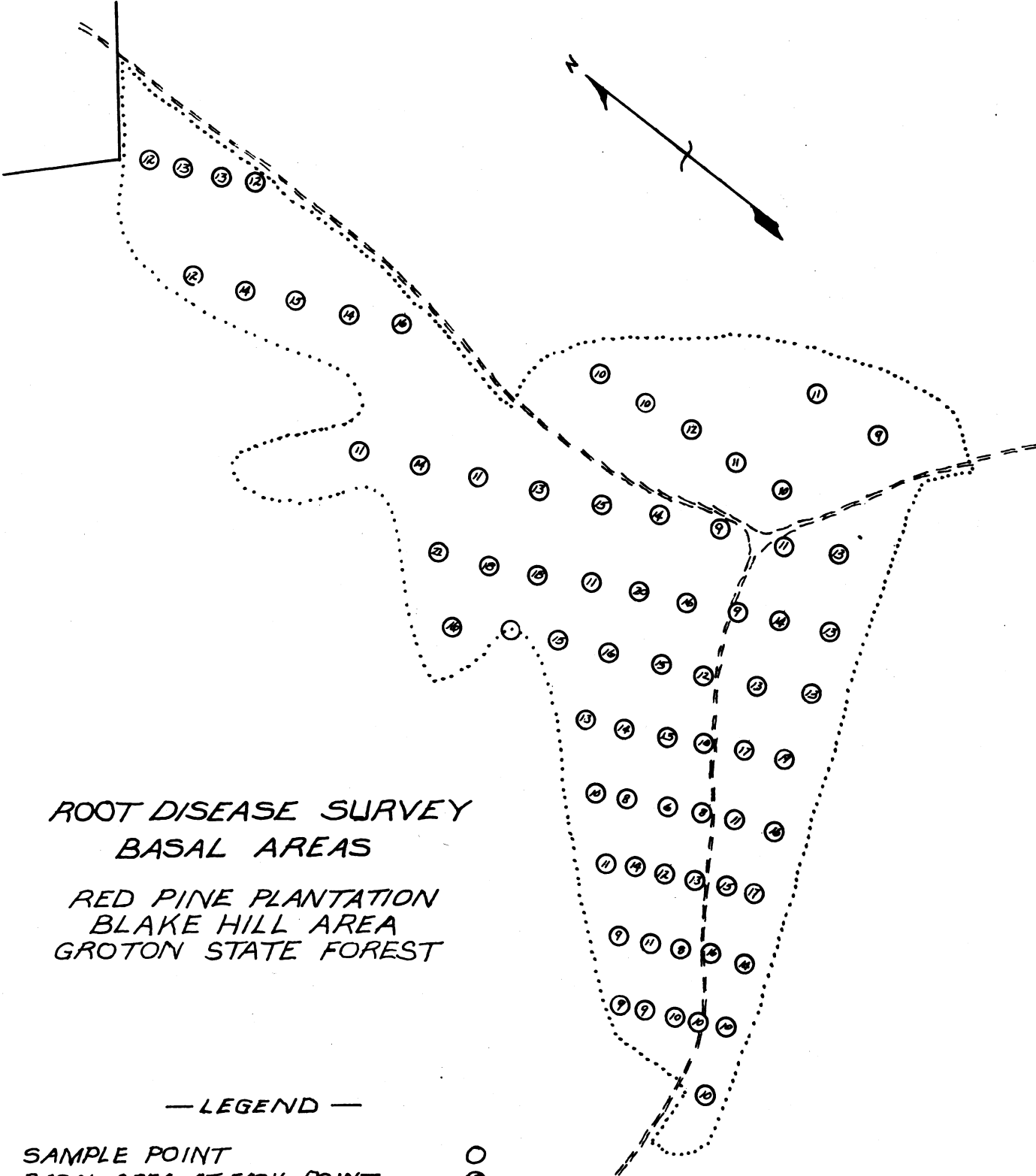
ROOT DISEASE SURVEY
SAMPLE DISTRIBUTION
RED PINE PLANTATION
BLAKE HILL AREA
GROTON STATE FOREST

LEGEND

SAMPLE POINT
TREE NUMBER
PLOT LINE LETTER
PLANTATION BOUNDARY
JEEP OR TRUCK ROAD
STATE FOREST BOUNDARY

○
②
A, B, ETC.
.....
- - - - -
—————

SCALE : 1" = 5 CHNS.



ROOT DISEASE SURVEY
BASAL AREAS
RED PINE PLANTATION
BLAKE HILL AREA
GROTON STATE FOREST

— LEGEND —

SAMPLE POINT
BASAL AREA AT EACH POINT
(APPLY BAF 10)
PLANTATION BOUNDARY
JEEP OR TRUCK ROAD
STATE FOREST BOUNDARY

○
③
.....
- - - - -
—————

SCALE : 1" = 5 CHNS.